

What is claimed is:

1. A resource management unit for managing one or a plurality of resources, comprising:

5 a first section that, upon accepting a tentative reservation request designating at least one resource, changes a free time period of said designated resource to a tentatively reserved time period based on said tentative reservation request, said first section storing therein information of a valid time period and a issuer of said tentative reservation request;

10 a storage unit for storing at least one said tentative reservation request in a wait queue disposed corresponding to each designated resource for which another tentative reservation request designating said tentatively reserved time period already exists; and

15 a second section that issues information of said tentatively reserved time period and a corresponding tentative reservation ID in response to said tentative reservation request.

2. The resource management unit according to claim 1, further comprising:

5 a third section that, upon accepting a tentative reservation cancel request designating said tentative reservation ID, cancels said tentative reservation time

period to revive said free time period.

3. The resource management unit according to claim 1, further comprising:

5 a fourth section that, upon receiving a job reservation request designating said tentative reservation ID and a reservation time period, changes  
said reservation time period designated by said job reservation request to an actually reserved time period, if said reservation time period designated by said job reservation request is included in said tentatively-  
10 reserved time period corresponding to said designated tentative reservation ID and a issuer of said job reservation request matches with said issuer of said tentative reservation request.

4. The resource management unit according to claim 2, further comprising:

5 a fifth section that cancels said tentatively reserved time period for which said validity time period has expired to thereby revive said free time period;

a sixth section that reads out said tentative reservation request stored in said wait queue, said sixth section changing said free time period revived by said fifth section to another tentatively reserved time period

10 based on said read-out tentative reservation request,  
said sixth section storing information of an issuer of  
said read-out tentative reservation request; and

a seventh section that issues said another  
tentatively reserved time period changed by said sixth  
15 section and a corresponding tentative reservation ID to  
the issuer of said read-out tentative reservation request.

5. A job scheduler communicated with at least  
one resource management unit for scheduling a job,  
said job controller comprising:

a first member that issues a tentative reservation  
5 request designating each resource of a plurality of  
resources to be used in a job, to a resource management  
unit managing said each resource;

a second member that receives a notification of a  
tentatively reserved state of said each resource or  
10 storage of said tentative reservation request in a wait  
queue in response to said tentative reservation request;

a third member that assigns the job to at least one  
first resource, for which said tentatively reserved state  
is received and selected from among said plurality of  
15 resources, while excluding at least one second resource  
among said plurality of resources, to create a job  
schedule including an execution time period of each of

said first resource;

20 a fourth member that issues a job reservation request for said first resource, to said resource management unit managing said first resource; and

a fifth member that issues a tentative reservation cancel request for said second resource, to said resource management unit managing said second resource.

6. The job scheduler according to claim 5, further comprising:

5 a sixth member that, after receiving a notification of storage of said tentative reservation request in said wait queue from said resource management unit, controls said third member to create said job schedule either after a designated time interval elapsed since receiving said notification without a further notification, or after receiving another notification that said  
10 tentative reservation request is taken out of said wait queue to said tentatively reserved state.

7. A distributed resource management system comprising:

5 at least one said resource management unit according to claim 1; and a job scheduler communicated with said resource management unit, said job scheduler

comprising:

10 a first member that issues a tentative reservation request designating each resource of a plurality of resources to be used in a job, to said resource management unit managing said each resource;

a second member that receives information of a tentatively reserved state of said each resource from said resource management unit;

15 a third member that assigns the job to at least one first resource, for which said tentatively reserved state is received and selected from among said plurality of resources, while excluding at least one second resource among said plurality of resources, to create a job schedule including an execution time period of each of  
20 said first resource;

a fourth member that issues a job reservation request for said first resource, to said resource management unit managing said first resource; and

25 a fifth member that issues a tentative reservation cancel request for said second resource, to said resource management unit managing said second resource.

8. A distributed resource management system comprising:

at least one resource management unit that

manages one or a plurality of resources; and

5           at least one job scheduler communicated with said  
at least one resource management unit, said job  
scheduler having a job reservation function including  
issuing a tentative reservation request for a plurality of  
resources to be used in a job,

10           said resource management unit comprising:

          a first section that receives two kinds of  
reservation requests for tentative reservation and job  
reservation, issued by said job scheduler, wherein said  
tentative reservation is a combinational operation of  
15   acquiring a reservation state of resources and trying to  
tentatively reserve resources, and is performed  
designating at least one resource managed by said  
resource management unit;

          a second section that, if a resource for which  
20   said tentative reservation request received from said job  
scheduler does not have another tentative reservation  
and has a free time period thereof, sets a tentatively  
reserved state for said resource and issues information  
of said tentatively reserved state including a tentatively  
25   reserved time period in response to said tentative  
reservation request;

          a third section that stores a validity time period  
and information of said job scheduler having issued said

tentative reservation request in connection with said  
30 tentatively reserved time period, wherein said job  
reservation includes an operation of reserving resources  
in advance for execution of a designated job and is  
performed via a job reservation request designating at  
least one resource that is managed by said resource  
35 management unit and a reservation time period of said  
resource;

a fourth section that accepts said job reservation  
request and changes the reservation time period  
specified by said job reservation request to a job  
40 reserved state, if the specified time period is included in  
a tentatively-reserved time period and the issuer of said  
job reservation request matches with the issuer of the  
tentative reservation request; and

a fifth section that, when it reaches a start time  
45 specified by the job reservation, controls to allocate the  
resource for execution of the job and/or, when it reaches  
an end time specified by said job reservation, controls to  
release allocation of the resource to the job.

9. The distributed resource management system  
according to claim 8, wherein said resource  
management unit accepts two kinds of cancel requests  
including tentative reservation cancel request and a job

- 5 cancel request issued corresponding to said two kinds of reservation requests by said job scheduler.

10. The distributed resource management system according to claim 8, further comprising at least one user terminal communicated with said job scheduler for inputting through said user terminal a job  
5 to said job scheduler, wherein said job scheduler comprises a first member that assigns said job input through said user terminal to resources,

said assignment to resources by said job scheduler including at least one of:

- 10 a process of issuing a tentative reservation request to said resource management unit;

a process of creating an execution schedule of the job for resources for which said tentative reservation was successful; and

- 15 a process of issuing a job reservation request according to said execution schedule to said resource management unit.

11. The distributed resource management system according to claim 8, wherein said resource management unit comprises:

a schedule storage unit that stores, for each



5 resource managed by said resource management unit,  
information of said job designating said each resource  
and the time period for which said each resource is  
reserved;

10 a tentative-reservation-request storage unit that  
has a wait queue for each resource managed by said  
resource management unit, wherein a waiting tentative  
reservation request for said resource is stored in said  
wait queue;

15 a tentative-reservation-request receiving section  
that receives a tentative reservation request from said  
job scheduler and stores information of the tentative  
reservation in said schedule storage unit or said  
tentative-reservation-request storage unit;

20 a job-reservation-request receiving section that  
receives a job reservation request from said job  
scheduler and stores information of the job reservation  
in said schedule storage unit; and

25 a schedule management section that monitors the  
information of the job reservation and the tentative  
reservation stored in said schedule storage unit and  
performs allocation and release of resources, and/or  
discard of said tentative reservation according to the  
information of said job reservation and said tentative  
reservation.

12. The distributed resource management system according to claim 11, wherein said resource management unit comprises:

5 a tentative-reservation-cancel-request receiving section that receives a tentative reservation cancel request from said job scheduler and discards information of a corresponding tentative reservation from said schedule storage unit or said tentative-reservation-request storage unit; and

10 a job-cancel-request receiving section that receives a job reservation cancel request from said job scheduler and discards information of a corresponding job reservation from said schedule storage unit and releases resources allocated to the job.

13. The distributed resource management system according to claim 8, wherein said job scheduler comprises:

5 a waiting-job storage unit that temporarily stores information of a job input through said user terminal;

a schedule storage unit that stores information of a job for which reservation is confirmed for each resource;

a job-execution-request receiving member that

10 receives a job execution request from said user terminal  
and stores contents of said job execution request in said  
waiting-job storage unit;

15 a job scheduling member that takes out a job  
stored in said waiting-job storage unit and assigns the  
job to resources, said assignment of the job to resources  
including the issuing of a tentative reservation request  
to said resource management unit, the creation of a job  
execution schedule, and issuing of a job reservation  
request to said resource management unit.

14. The distributed resource management  
system according to claim 13, wherein said job  
scheduler comprises:

5 a job-cancel-request receiving member that, upon  
receiving a job cancel request from said user terminal,  
discards a waiting job stored in said waiting-job storage  
unit or a corresponding job registered in said schedule  
storage unit, and issues a job reservation cancel request  
to said resource management unit.

15. The distributed resource management  
system according to claim 8, wherein said resource  
management unit further comprises:

a sixth section that assigns resources managed by

5 said resource management unit for execution of said job according to a job reservation request received from said job scheduler; and

10 a seventh section that, upon receiving a tentative reservation request for already, tentatively reserved resources, stores said tentative reservation request in a wait queue provided for each of the resources, wherein when a tentative reservation is discarded due to a tentative reservation cancel request or the expiration of a validity time period, a tentative reservation request  
15 directed to the same resource as the discarded tentative reservation is taken out of the wait queue, and becomes a valid tentative reservation,

20 an eighth section that, when the tentative reservation request is taken out of said wait queue, issues a notification of said valid tentative reservation to said job scheduler having issued said tentative reservation request,

said job scheduler further comprising:

25 a first member that controls such that, when the tentative reservation request issued by said job scheduler has entered said wait queue, creation of job execution schedule waits until said tentative reservation becomes valid and then starts the creation of an execution schedule thereof.

16. The distributed resource management system according to claim 14, wherein said first member of said job scheduler further controls such that, if the tentative reservation request does not become  
5 valid for the tentative reservation request in a predetermined time interval until, the process proceeds to said creation of said job execution schedule while excepting the resource corresponding to the tentative reservation request stored in said wait queue.

17. A method for use in a resource management unit that manages one or a plurality of resources, comprising the steps of:

upon accepting a tentative reservation request  
5 designating at least one resource, changing a free time period of said designated resource to a tentatively reserved time period based on said tentative reservation request, and storing a valid time period and a issuer of said tentative reservation request;

10 storing at least one said tentative reservation request in a wait queue disposed corresponding to each designated resource for which another tentative reservation request designating said tentatively reserved time period already exists; and

15           issuing information of said tentatively reserved  
time period and a corresponding tentative reservation  
ID in response to said tentative reservation request.

18. The method according to claim 17, further  
comprising the step of:

          upon accepting a tentative reservation cancel  
request designating said tentative reservation ID,  
5   canceling said tentative reservation time period to  
revive said free time period.

19. The method according to claim 17, further  
comprising the step of:

          upon receiving a job reservation request  
designating said tentative reservation ID and a  
5   reservation time period, changing said reservation time  
period designated by said job reservation request to an  
actually reserved period, if said reservation time period  
designated by said job reservation request is included in  
said tentatively-reserved time period corresponding to  
10   said designated tentative reservation ID and a issuer of  
said job reservation request matches with said issuer of  
said tentative reservation request.

20. The method according to claim 17, further

comprising the steps of:

canceling said tentatively reserved time period for  
which said validity time period has expired to revive  
5 said free time period;

reading out said tentative reservation request  
stored in said wait queue,

changing said free time period revived by said  
fifth section to another tentatively reserved time period  
10 based on said read-out tentative reservation request,

storing information of an issuer of said read-out  
tentative reservation request; and

issuing said another tentatively reserved time  
period changed by said changing step and a  
15 corresponding tentative reservation ID to the issuer of  
said read-out tentative reservation request.

21. A method for use in a job scheduler,  
communicated with one or a plurality of resource  
management units, for scheduling a job, said method  
comprising the steps of:

5 issuing at least one tentative reservation request  
designating a plurality of said resources to be used in a  
job to at least one resource management unit managing  
said plurality of said resources;

receiving a notification of a tentatively reserved

10 state of said each resource or storage of said tentative reservation request in a wait queue in response to said tentative reservation request;

assigning the job to at least one first resource, for which said tentatively reserved state is received and  
15 selected from among said plurality of resources, while excluding at least one second resource among said plurality of resources, to create a job schedule including an execution time period of each of said first resource;

issuing a job reservation request for said first  
20 resource, to said resource management unit managing said first resource; and

issuing a tentative reservation cancel request for said second resource, to said resource management unit managing said second resource.

22. The method according to claim 21, further comprising the step of:

controlling, after receiving a notification of storage of said tentative reservation request in said  
5 wait queue from said resource management unit, said third member to create said job schedule either after a designated time interval elapsed since receiving said notification without a further notification, or after receiving another notification that said tentative



10 reservation request is taken out of said wait queue to  
said tentatively reserved state.

23. A method for use in a distributed resource  
management system including at least one resource  
management unit for managing at least one resource  
and at least one job scheduler communicated with said  
5 resource management unit, having a job reservation  
function including issuing a tentative reservation  
request for a plurality of resources to be used in a job,  
said method comprising the steps of :

receiving two kinds of reservation requests for  
10 tentative reservation and job reservation in said  
resource management unit, issued by said job scheduler,  
wherein said tentative reservation is a combinational  
operation of acquiring a reservation state of resources  
and trying to tentatively reserve resources, and is  
15 performed designating at least one resource managed  
by said resource management unit;

setting in said resource management unit a  
tentatively reserved state for said resource and issuing  
said tentatively reserved state including a tentatively  
20 reserved time period in response to said tentative  
reservation request, if a resource for which said  
tentative reservation request received from said job

scheduler does not have another tentative reservation and has a free time period thereof;

25       storing in said resource management unit a validity time period and information of said job scheduler having issued said tentative reservation request in connection with said tentatively reserved time period, wherein said job reservation includes an  
30       operation of reserving resources in advance for execution of a designated job and is performed via a job reservation request designating at least one resource that is managed by said resource management unit and a reservation time period of said resource;

35       accepting by said resource management unit said job reservation request and changing the time period designated by said job reservation request to a job-reserved state, if the designated time period is included in a tentatively-reserved time period and the issuer of  
40       said job reservation request matches with the issuer of the tentative reservation request; and

          controlling to allocate the resource for execution of the job, when it reaches a start time designated by the job reservation, and/or to release allocation of the  
45       resource to the job, when it reaches an end time designated by said job reservation.

24. The method according to claim 23, wherein  
said resource management unit accepts two kinds of  
cancel requests including a tentative reservation cancel  
request and a job cancel request issued corresponding to  
5 said two kinds of reservation requests by said job  
scheduler.

25. The method according to claim 23, further  
comprising the step of assigning a job to resources in  
said job scheduler, said job being input from a user  
terminal to said job scheduler, said assigning step  
5 comprising the steps of:

issuing a tentative reservation request to said  
resource management unit;

creating an execution schedule of the job for  
resources for which said tentative reservation was  
10 successful; and

issuing a job reservation request according to said  
execution schedule to said resource management unit.

26. The method according to claim 23, further  
comprising, upon receiving said tentative reservation  
request in said resource management unit, the steps of:

storing information of a corresponding tentative  
5 reservation in a schedule storage unit or in a wait

queue provided in said resource management unit for each of said resources;

upon receiving said job reservation request in said resource management unit, storing information of a  
10 corresponding job reservation in said schedule storage unit; and

monitoring the information of said job reservation and said tentative reservation, to perform allocation and release of resources, and/or discard said tentative  
15 reservation based on the information of said job reservation and said tentative reservation.

27. The method according to claim 23, further comprising the steps of:

receiving a tentative reservation cancel request in said resource management unit from said job scheduler  
5 to discard information of a corresponding tentative reservation from said schedule storage unit or said wait queue; and

receiving a job reservation cancel request from said job scheduler to discard information of a  
10 corresponding job reservation from said schedule storage unit and release resources allocated to the job.

28. The method according to claim 23, further

comprising the steps of:

receiving a job execution request from said user terminal to store contents of a corresponding job in said job scheduler; and

creating a job schedule corresponding to said job execution request in said job scheduler, wherein said assignment of the job to resources including the issuing of a tentative reservation request to said resource management unit, the creation of a job execution schedule, and the issuing of a job reservation request to said resource management unit.

29. The method according to claim 28, further comprising, upon receiving a job cancel request from said user terminal in said job scheduler, the steps of:

upon receiving a job cancel request from said user terminal, discarding in said job scheduler a waiting job stored in a waiting job storage unit or a corresponding job registered in said schedule storage unit; and

issuing a job reservation cancel request from said job scheduler to said resource management unit.

30. The method according to claim 23, further comprising the steps of:

allocating resources managed by said resource

management unit to execution of said job according to a  
5 job reservation request received from said job scheduler;

upon receiving a tentative reservation request for  
already, tentatively reserved resources, storing said  
tentative reservation request in a wait queue provided  
for each of the resources, wherein when a tentative  
10 reservation is discarded due to a tentative reservation  
cancel request or the expiration of a validity time period,  
a tentative reservation request directed to the same  
resource as the discarded tentative reservation is taken  
out of the wait queue, and becomes a valid tentative  
15 reservation,

upon the tentative reservation request being  
taken out of said wait queue, issuing a notification of  
said valid tentative reservation from said resource  
management unit to said job scheduler having issued  
20 said tentative reservation request;

controlling in said job scheduler such that, when  
the tentative reservation request issued by said job  
scheduler has entered said wait queue, creation of job  
execution schedule waits until said tentative  
25 reservation becomes valid and then starts the creation  
of an execution schedule thereof.

31. The method according to claim 30, further

comprising the step of: at the end of the predetermined time period, ignoring the tentative reservation request stored in said wait queue and proceeding to the creation  
5 of an execution schedule, if the tentative reservation request does not become valid in a predetermined time period.

32. A distributed resource management system comprising:

a resource management unit for managing at least one resource;

5 a job scheduler communicated with said resource management unit to schedule a job to use said resources; and

a user terminal communicated with said job scheduler for consecutively issuing a tentative  
10 reservation request and a job reservation request for each said resource to said resource management unit;

said resource management unit comprising:

a first section that receives said tentative reservation request from said job scheduler to set a  
15 resource designated by said tentative reservation request in a tentatively reserved state; and a second section that, when a tentative reservation request is issued for an already, tentatively reserved resource,

stores the tentative reservation request in a wait queue,  
20 wherein said user terminal requests said job scheduler  
to execute a job, and wherein said job scheduler  
comprises a first member that, after issuing a tentative  
reservation request to said resource management unit,  
determines resources to which the job is assigned and  
25 issues a job reservation request to said resource  
management unit to reserve the resources necessary for  
execution of the job.

33. A distributed resource management method  
for a distributed resource system including at least one  
resource management unit that manages one or a  
plurality of resources; at least one job scheduler  
5 communicated with said at least one resource  
management unit and schedules a job to use said  
resources; and at least one user terminal communicated  
with said job scheduler, said method comprising the  
steps of:

10 consecutively issuing a tentative reservation  
request and a job reservation request from said job  
scheduler for each said resource to said resource  
management unit;

after a tentative reservation request is issued for  
15 an already, tentatively reserved resource from said job



scheduler, storing said tentative reservation request in a wait queue of said resource management unit; and

after issuing a tentative reservation request to said resource management unit for each said resource,  
20 said job scheduler determining resources to which the job is assigned and issuing a job reservation request to said resource management unit to reserve the resources necessary for execution of the job.

34. A program for running on a computer constituting a resource management unit, which manages one or a plurality of resources, said program defining the steps of:

5 upon accepting a tentative reservation request designating at least one resource, changing at least one free time period of said resource to a tentatively reserved time period, and storing information of a validity time period and the issuer of said tentative  
10 reservation request in a storage unit;

storing said tentative reservation request in a wait queue for one of said at least one resource that already has a tentatively-reserved time period; and

issuing information of said tentatively reserved  
15 time period and tentative reservation ID in response to said tentative reservation request.

35. The program according to claim 34, further defining the step of:

upon accepting a tentative reservation cancel request designating said tentative reservation ID, canceling a tentative reservation corresponding to said tentative reservation ID to cancel said tentatively reserved time period to revive said free time period.

36. The program according to claim 34, further defining the steps of:

upon receiving a job reservation request designating said tentative reservation ID and a request time period, changing said request time period designated by said job reservation request to a job-reserved time period, if said request time period is included in said tentatively-reserved time period corresponding to said tentative reservation ID and the issuer of said job reservation request matches with the issuer of said tentative reservation request.

37. The program according to claim 34, further defining the steps of:

canceling said tentatively-reserved time period for which said validity time period has expired to revive

5     said free time period;

          taking a tentative reservation request out of said  
wait queue, changing said revived free time period to  
another tentatively reserved time period based on said  
taken out tentative reservation request, and storing  
10    information identifying the issuer of said taken out  
tentative reservation request in the storage unit; and

          issuing a notification of said another tentatively  
reserved time period and a tentative reservation ID  
corresponding to said another tentatively reserved time  
15    period to the issuer thereof.

38.    A program for running on a computer  
constituting a job scheduler, that is communicated with  
a resource management unit, which manages one or a  
plurality of resources, said program defining the steps  
5    of:

          issuing a tentative reservation request for each of  
resources to be used by a job to said resource  
management unit managing the resource;

          selecting resources to which said job is assigned  
10    from among resources that are tentatively reserved by  
said resource management unit and determining a time  
period for execution;

          issuing a job reservation request for each of the

resources determined by said selecting step to said  
15 resource management unit managing said selected  
resource; and

issuing a tentative reservation cancel request for  
at least one of the resources tentatively reserved by said  
tentative reservation request issuing step to said  
20 resource management unit managing the resource.

39. The program according to claim 38, further  
defining the steps of:

upon storing said tentative reservation request in  
a wait queue of said resource management unit, said  
5 job scheduler controlling to proceed to said selecting  
step after a predetermined time period has elapsed or a  
notification of said tentative reservation request having  
been taken out of said wait queue has arrived.